Exhaust System for an Internal Combustion Engine

This application is a § 371 of PCT/EP2004/012843, filed November 12, 2004, claiming priority from DE 103 60 072.8, filed December 20, 2003, each of which is hereby incorporated by reference in its entirety.

Field

The invention relates to an exhaust system for a an internal combustion engine on a vehicle, in particular a motor vehicle, as specified in the preamble of claim 1.

Background

A generic, universally known exhaust system for an internal combustion system of a motor vehicle has an exhaust catalytic converter and a probe assembly in the area of the exhaust catalytic converter as a component of a lambda control device. By means of the lambda control device the internal combustion engine, as a function of the probe signals detected by the probe assembly, may be switched alternately between a lean-fuel operating range, in which the internal combustion engine is operated with a lean mixture having excess air and thus excess oxygen and a rich-fuel operating range, in which the internal combustion engine is operated with an air deficiency and thus oxygen deficiency.

Specifically, a lambda pilot probe is mounted upstream from the exhaust catalytic converter and a lambda control probe downstream from the catalytic converter. The lambda pilot probe is a so-called constant lambda probe, which is used for lambda control upstream from the catalytic converter. It is capable of detecting a relatively wide lambda signal in the range of about 0.7 to about 2. The object of using the probe is to measure deviation of the lambda generated by the engine from the assigned lambda. The lambda control probe, which is a binary lambda probe, generally can detect the passage only when lambda=1, but with very high accuracy. Such high accuracy is required for equalization to precisely lambda=1. Appropriate wiring is required for both sensors; the required structural space must also be present for both sensors.

Summary

The object of the invention is to create an exhaust system for an internal combustion engine of a vehicle, a motor vehicle in particular, a system which may be produced by a simpler structural method with constant high operational reliability remaining the same. This object is attained by means of the features ~~specified in claim 1~~ of various embodiments.

~~Claim 1 states that~~ According to one embodiment, the probe assembly is in the form of a single lambda probe delivering a constant probe signal. The probe is mounted downstream from the exhaust catalytic converter. In conjunction with the lambda probe control device it determines over the entire length of the lean-fuel operating phase the increase in the amount of oxygen in the exhaust gas flow and over the entire length of the rich-fuel operating phase the decrease in the amount of oxygen in the exhaust gas flow in each instance in relation to a specified oxygen amount reference value. A threshold switching value dependent on the amount of oxygen is assigned in both the lean-fuel operating phase and the rich-fuel operating phase; when this value is reached, the lambda control device is switched to the respective other operating area.

It is especially advantageous that use may be made in such a configuration of a single constant lambda probe mounted downstream from the exhaust catalytic converter to regulate the operation of the internal combustion engine reliably by means of the lambda control device as a function of the oxygen balance proportional to the lambda signal, even in the absence of a control probe mounted upstream from the exhaust catalytic converter. The component cost may be advantageously reduced as a result.

In another especially preferred configuration~~, as specified in claim 2,~~ the threshold switching value ~~specified in claim 2~~ may also be determined and/or adapted as a function of an oxygen storage capacity of the exhaust catalytic converter and/or a degree of conversion of one or more pollutant components. The accuracy may be increased further by taking these values into account.

As an alternative, however, the "threshold switching value" ~~specified in claim 3~~ may be in the form of gradients of increase in oxygen or decrease in oxygen of the exhaust downstream from the catalytic converter.

In addition, ~~as specified in claim 4~~ in certain embodiments, provision is made such that the threshold switching value is plotted in a performance graph of the engine control device.

By special preference the oxygen amount reference value specified ~~in claim 5~~, in certain embodiments, is in the form of the preceding threshold switching value. In principle, however, the oxygen amount reference value may also be a permanent specified value.

As a general rule, then, an exhaust system such as this as claimed for the invention provides a simple and reliable option for control of the operation of an internal combustion engine. The engine component construction cost is also lowered.

Brief Description of the Drawings

The invention will be described below with reference to a drawing, in which

FIG. 1 presents a diagram of the variation over time of the probe signal of the permanent lambda probe mounted downstream from the exhaust catalytic converter,

FIG. 2 presents a diagram corresponding to that of FIG. 1, one in which the pattern of variation in the oxygen balance upstream from the exhaust catalytic converter is shown by a broken line based on the measured constant lambda probe signal,

FIG. 3 presents a diagram of conversion of the pollutants CO and NO_2 over time in accordance with the mode of operation in FIG. 1.

Detailed Description

A constant probe signal measured by means of a single permanent lambda probe mounted downstream from an exhaust catalytic converter is presented as an example in FIG. 1 as a function of the oxygen balance and time. The times of switching between a lean-fuel operating range and a rich-fuel operating range as a function of the threshold switching values derived from the prescribed increase or decrease in the amount of oxygen may now be determined on the basis of this trace of the curve. For example, appropriate threshold switching values such as the threshold switching values U_1 and U_2 characterizing an upward or downward peak in the diagram may be specified in a diagram of an engine control device. The threshold switching values may, however, also

be determined in the form of the gradients of increase and/or decrease in oxygen in the exhaust flow. If the increase in the amount of oxygen in the exhaust flow over the entire period of a first lean-fuel operation phase is now plotted against an initial oxygen amount reference value U_0 from time t_0 in conjunction with the curve shown in FIG. 1 by means of the single lambda probe in conjunction with the lambda control device, switching from the lean-fuel operation phase to the rich-fuel operation phase may be effected by the lambda control device when the specified switching value U_1 is reached. This switching is illustrated by a broken line in the diagram in FIG. 2.

Accordingly, over the entire period of the rich-fuel operating phase following the lean-fuel operating phase the lambda probe may be employed in conjunction with the lambda probe device to determine the decrease in the amount of oxygen in the exhaust flow in relation to the threshold switching value U_1 but also in relation to U_0 until the switching value U_2 determined as a function of the amount of oxygen reached in the rich-fuel operating phase, as a result of which switching to the lean-fuel operating range is effected again by the lambda control device. Consequently, the broken-line pattern of a signal upstream from the catalytic converter illustrated in FIG. 2 may be modeled exclusively on the basis of a constant oxygen signal measured upstream by means of a single lambda probe. In this way a probe, i.e., a so-called pilot probe, may be advantageously dispensed with upstream from the exhaust catalytic converter.

The connection to conversion of NO_2 (thin line) and CO (bold line) is shown in FIG. 3. The conversion of NO_2 decreases constantly after time t_0 as starting point, this making it necessary to switch to rich-fuel operation at time t_1. This rich-fuel operation is continued up to time t_2 until the conversion of CO drops again. These conversion results, which may be derived from the downstream catalytic converter probe signal, may be used in evaluating and determining the threshold values for switching between the individual phases of operation, as a result of which the accuracy of the switching cycle may be substantially increased even further.

The threshold switching values U_1 and U_2 are situated here only by way of examples at the peak of the downstream catalytic converter probe signals. From the viewpoint both of time and amount of oxygen they may also occur in advance of the

peak, for example, at U_1 and U_2, as is illustrated only in diagram form and by way of example in FIG. 1.